40667 2008/081

UNIVERSITI SAINS MALAYSIA

UNIVERSITY RESEARCH GRANT FINAL REPORT

Geran Penyelidikan Universiti Laporan Akhir

A.	**TITLE OF RESEARCH:** *Tajuk penyelidikan:* A Neural Network Approach to Synthetic Control Chart for the Process Mean
B.	**PERSONAL PARTICULARS OF RESEARCHER** / *MAKLUMAT PENYELIDIK:*
(i)	**Name of Research Leader:** *Nama Ketua Penyelidik:* Prof. Michael Khoo Boon Chong
	Name of Co-Researcher *Nama Penyelidik Bersama:* Prof. Madya Low Heng Chin Dr. Ong Hong Choon
(ii)	**School/Institute/Centre/Unit :** *Pusat Pengajian /Institut/Pusat/Unit :* Pusat Pengajian Sains Matematik

C. Research Platform (Please tick (/) the appropriate box):
Pelantar Penyelidikan (Sila tanda (/) kotak berkenaan):

☐	**A. Life Sciences** *Sains Hayat*
√	**B. Fundamental** *Fundamental*
☐	**C. Engineering & Technology** *Kejuruteraan & Teknologi*
☐	**D. Social Transformation** *Transformasi Sosial*
☐	**E. Information & Communications Technology (ICT)** *Teknologi Maklumat & Komunikasi*
☐	**F. Clinical Sciences** *Sains Klinikal*
☐	**G. Biomedical & Health Sciences** *Bioperubatan Sains Kesihatan*

D.	**Duration of this research :** *Tempoh masa penyelidikan ini :* ***Duration :** 3 tahun *Tempoh :* **From** : 22 Oktober 2007 **To** : 30 September 2010 *Dari:* *Ke :*

E. **ABSTRACT OF RESEARCH**

(An abstract of between 100 and 200 words must be prepared in **Bahasa Malaysia and in English**. This abstract will be included in the Annual Report of the Research and Innovation Section at a later date as a means of presenting the project findings of the researcher/s to the University and the community at large)

In this project, a multivariate synthetic control chart for monitoring the process mean vector of skewed populations using weighted standard deviations has been proposed. The proposed chart incorporates the weighted standard deviation (WSD) method of Chang and Bai (2004) into the standard multivariate synthetic chart of Ghute and Shirke (2008). The standard multivariate synthetic chart consists of the Hotelling's T^2 chart and the conforming run length (CRL) chart. The results show that the proposed chart performs better than the existing multivariate charts for skewed populations, in terms of false alarm rates and moderate and large mean shift detection rates based on the various degrees of skewnesses. This project also suggest a synthetic double sampling (DS) chart for the mean. The synthetic DS chart comprises a DS sub-chart and a CRL sub-chart. The DS chart was proposed by Daudin (1992) while the CRL chart was suggested by Bourke (1991). The synthetic DS chart outperforms both of its standard counterparts, namely the synthetic chart of Wu and Spedding (2000) and the DS chart of Daudin (1992). In addition, a comparison between statistical charts and neural network based charts is made, where the results indicate that neural network based charts perform better.

References

1. Bourke, P. D. (1991). Detecting a Shift in Fraction Nonconforming Using Run-Length Control Charts with 100% Inspection. *Journal of Quality Technology* 23, 225-238.

2. Chang, Y. S., Bai, D. S. (2004). A multivariate T^2 control chart for skewed populations using weighted standard deviations. *Quality and Reliability Engineering International* 20, 31–46.

3. Daudin, J. J. (1992). Double Sampling $\bar{X}$ Charts. *Journal of Quality Technology* 24, 78-87.

4. Ghute VB and Shirke DT. (2008). A multivariate synthetic control chart for monitoring process mean vector. *Communications in Statistics – Theory and Methods* 37, 2136 − 2148.

5. Wu, Z. and Spedding, T. A. (2000). A Synthetic Control Chart for Detecting Small Shifts in the process Mean. *Journal of Quality Technology* 32, 32-38.

Abstrak Penyelidikan

(Perlu disediakan di antara 100 - 200 perkataan di dalam **Bahasa Malaysia dan juga Bahasa Inggeris**. Abstrak ini akan dimuatkan dalam Laporan Tahunan Bahagian Penyelidikan & Inovasi sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti & masyarakat luar).

Dalam projek ini, suatu carta kawalan sintetik multivariat untuk pemantauan vektor min proses bagi taburan terpencong dengan menggunakan sisihan piawai berpemberat telah dicadangkan. Carta yang dicadangkan menggabungkan kaedah sisihan piawai berpemberat (WSD) Chang dan Bai (2004) dengan carta sintetik multivariat asas Ghute dan Shirke (2008). Carta sintetik multivariat asas terdiri daripada carta T^2 Hotelling dan carta *conforming run length* (CRL). Keputusan menunjukkan bahawa carta yang dicadangkan memberi prestasi yang lebih baik daripada carta multivariat sedia ada untuk populasi terpencong, daripada segi kadar isyarat palsu dan kadar pengesanan anjakan sederhana dan besar dalam min, berdasarkan pelbagai darjah kepencongan. Projek ini juga mencadangkan suatu carta pensampelan berganda (DS) sintetik untuk min. Carta DS sintetik terdiri daripada carta DS dan carta CRL. Carta DS dicadangkan oleh Daudin (1992) manakala carta CRL dicadangkan oleh Bourke (1991). Carta DS sintetik mempunyai prestasi yang lebih baik daripada kedua-dua carta asasnya, iaitu carta sintetik Wu dan Spedding (2000) dan carta DS Daudin (1992). Tambahan pula, suatu perbandingan antara carta berstatistik dan carta berasaskan rangkaian neural telah dilakukan, yang mana keputusan menunjukkan bahawa carta berasaskan rangkaian neural mempunyai prestasi yang lebih baik.

Rujukan

1. Bourke, P. D. (1991). Detecting a Shift in Fraction Nonconforming Using Run-Length Control Charts with 100% Inspection. *Journal of Quality Technology* 23, 225-238.

2. Chang, Y. S., Bai, D. S. (2004). A multivariate T^2 control chart for skewed populations using weighted standard deviations. *Quality and Reliability Engineering International* 20, 31–46.

3. Daudin, J. J. (1992). Double Sampling $\overline{X}$ Charts. *Journal of Quality Technology* 24, 78-87.

4. Ghute VB and Shirke DT. (2008). A multivariate synthetic control chart for monitoring process mean vector. *Communications in Statistics – Theory and Methods* 37, 2136 – 2148.

5. Wu, Z. and Spedding, T. A. (2000). A Synthetic Control Chart for Detecting Small Shifts in the process Mean. *Journal of Quality Technology* 32, 32-38.

F. SUMMARY OF RESEARCH FINDINGS

Ringkasan dapatan Projek Penyelidikan

The main findings of this research are the proposed extensions on synthetic control charts that improve upon the performances of existing charts. Two papers have been published in ISI indexed journals and several others in local journals and conference proceedings.

G. COMPREHENSIVE TECHNICAL REPORT

Laporan Teknikal Lengkap

Applicants are required to prepare a comprehensive technical report explaining the project.
(This report must be attached separately)
Sila sediakan laporan teknikal lengkap yang menerangkan keseluruhan projek ini.
[Laporan ini mesti dikepilkan]

List the key words that reflect our research:

Senaraikan kata kunci yang mencerminkan penyelidikan anda:

English	Bahasa Malaysia
Synthetic control chart	Carta kawalan sintetik
Double sampling control chart	Carta kawalan berganda dua
Neural Network	Rangkaian Neural